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Arthroscopic injection of corticosteroids into the fibrous tissue of subchondral cystic lesions of the medial femoral condyle in horses: A retrospective study of 52 cases (2001–2006)

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Keywords: horse; stifle; subchondral cystic lesion; arthroscopic; corticosteroid

Summary

Reasons for performing study: **There are no published results of subchondral cystic lesions (SCLs) in the medial femoral condyle (MFC) treated with arthroscopic injection of corticosteroids into the lining of the cyst.**

Objectives: **1) To determine the success rate for treatment of SCLs in the MFC with arthroscopic injection of the fibrous tissue of the cyst with corticosteroids. 2) To identify any factors that may predict outcome.**

Hypotheses: **Injection of the fibrous tissue of SCLs of the MFC with corticosteroids utilising arthroscopic guidance yields a similar or higher chance for intended performance than does arthroscopic debridement as previously reported; this technique will be effective for treating SCLs in older horses.**

Methods: **Horses with clinical and radiographic evidence of a SCL in the MFC were injected with corticosteroids under arthroscopic guidance, and case records and radiographs were reviewed retrospectively. A telephone survey of referring veterinarians, owners and trainers was conducted.**

Results: **Thirty-five of 52 (67%) cases were classified as successful involving 73 SCLs of which 56 (77%) were classified as successful. There was no significant association between age group (age ≤3 years vs. >3 years) and outcome, or cyst configuration and outcome. Significantly more unilateral SCLs (28/31 [90%] SCLs) were classified as successful than bilateral (28/42: 67%). There were significant differences in outcome based on the surgeon operating the case and an association between pre-existing radiographic findings of osteophytes and negative outcome.**

Conclusions: **Injection of SCLs utilising arthroscopic guidance is an effective alternative method of surgical treatment of SCL.**

Potential relevance: **This technique offers a similar chance of success as has been reported with debridement and may allow for a shorter period of convalescence. If unsuccessful, the option remains to debride the cyst in a second surgery.**

Introduction

Subchondral cystic lesions (SCLs) found on the medial femoral condyle (MFC) are a common problem in horses (Baxter 1996), are usually located on the weightbearing surface of the joint and may be clinical or nonclinical in nature (Baxter 1996; McIlwraith 2002). Proposed mechanisms for development of SCLs include osteochondrosis (Rejno and Stromberg 1978; Pool 1993) and trauma (Verschooten and De Moor 1982; Baxter 1996). The osteochondrosis theory suggests that SCLs may form secondary to a defect in endochondral ossification followed by enfolding and necrosis of the cartilage (Baxter 1996). The trauma theory is supported by studies in which surgically created lesions to the cartilage and subchondral bone (Ray *et al.* 1996) or cartilage alone (Kold *et al.* 1986) resulted in the formation of subchondral cystic lesions. Both described pathogeneses may be applicable to the clinical manifestation of disease.

Conservative management of SCLs includes box stall rest with or without intra-articular medications. Medications used include intra-articular hyaluronan, corticosteroids and polysulphated glycosaminoglycans. Typically, surgery is recommended if no response is achieved after 3–4 months of stall rest (Baxter 1996). Historically, surgical management has been debridement of the cystic contents through an arthrotomy (White *et al.* 1998) or with arthroscopy (Howard *et al.* 1995; Baxter 1996; von Rechenberg *et al.* 1998; Smith *et al.* 2005). Supplemental surgical treatments include cancellous bone grafts (Kold and Hickman 1984; Jackson *et al.* 2000; Fortier and Nixon 2005), mosaic arthroplasty (Bodo *et al.* 2004; Fortier and Nixon 2005), and recently, chondrocytes or mesenchymal stem cells in fibrin glue (Fortier and Nixon 2005). Results of arthroscopic debridement of 39 cases reported a 56% success rate, which equated to 72% when censored for horses originally classified as unsuccessful due to unrelated problems such as subsequent colic and osteoarthritis (OA) (Howard *et al.* 1995). A major complication reported in that study was enlargement of the SCL, which was significantly associated with forage subsequent to debridement (Howard *et al.* 1995). Smith *et al.* (2005) reported on

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a series of 85 horses with SCL of the MFC treated with arthroscopic debridement. In that study, 64% of horses age 0–3 years returned to soundness, while only 34% of horses age >3 years returned to soundness.

A more recent surgical technique involves injecting the fibrous tissue of SCLs with corticosteroids under arthroscopic guidance in order to reduce the production of local inflammatory mediators. These inflammatory mediators, found in the fibrous tissue within cysts, recruit osteoclasts and were demonstrated to cause active resorption of bone *in vitro* (von Rechenberg *et al.* 2000). Based on this research, involving 2 of the authors (C.W.M. and D.D.F.), an arthroscopic technique of corticosteroid injection into the lining of the cyst was developed. Hypothesised advantages of this technique include a similar or increased chance of success as compared to debridement, shorter convalescence, lower risk of cystic enlargement and minimal disruption of the articular surface. In addition, if the procedure is unsuccessful, other surgical therapies can be offered such as arthroscopic debridement with or without other reconstructive techniques mentioned above.

The objectives in this study were to: 1) determine the success for treatment of SCLs in the MFC with arthroscopic injection of the fibrous tissue of the cyst with corticosteroids; and 2) identify any factors important in outcome such as age, breed, cyst type, cyst size, presence of osteophytes on radiographs or intended use. It was hypothesised that injecting the fibrous tissue with corticosteroids utilising arthroscopic guidance would yield a similar or higher chance for intended athletic use than does arthroscopic debridement as previously reported (Howard *et al.* 1995); and that the technique would be more effective for older horses than previously reported with debridement (Smith *et al.* 2005).

Materials and methods

Case selection

Records of 62 cases were reviewed in which SCLs of the MFC were diagnosed clinically and radiographically. All SCL were treated by arthroscopic injection of corticosteroids into the fibrous tissue within the cyst by surgeons from Colorado State University. Subject details, lameness data, lesion location and characteristics, surgical technique, and radiographic data (when available) were collected. Cases were included only if a minimum of 6 months follow-up was available.

Fig 1: Injection of the fibrous tissue of a SCL as viewed under arthroscopic guidance. Notice that the needle is penetrating the periphery of the lesion rather than entering the cloaca.

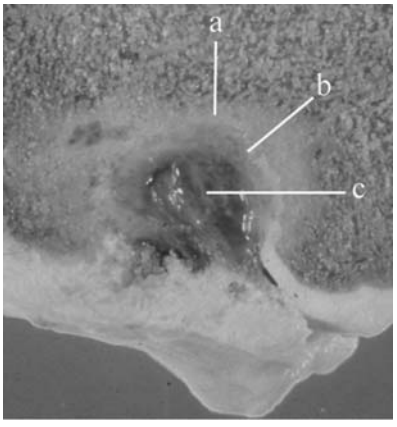

Fig 2: Post mortem *sagittal section showing the typical gross appearance of a subchondral cystic lesion. The lesion is surrounded by sclerotic subchondral bone (a). A dense layer of fibrous tissue is found just beneath the bone around the periphery of the cyst (b). The centre of the cyst is often filled with a gelatinous material (c).*

Surgical technique and aftercare

Surgical technique included a standard arthroscopic exploration of the medial femorotibial joint through a lateral approach followed by an injection of a corticosteroid into the fibrous tissue of the SCL under arthroscopic guidance through a cranial portal (Fig 1). An 18 gauge spinal needle was passed to the depth of the cyst until the bony margin of the cyst was contacted. This ensured that corticosteroid was deposited into the dense fibrous tissue found along the periphery of the cyst as opposed to the centre of the cyst (Fig 2). Some surgeons (Surgeons F and G) deposited the corticosteroid into a single location once the needle was presumed to be within the lining of the cyst. Other surgeons (Surgeons A, B, C, D, E and G) placed multiple injections in different locations of the fibrous tissue, either by advancing a bent needle in different directions through the cloaca, or by penetrating the cartilage around the cloaca multiple times in different locations.

Post operative care included 2 weeks stall rest, followed by in-hand walking beginning at 5 min daily and increasing by 5 min/week until the horse reached Day 30, 60 or 90 post operatively. This period of rest before re-evaluation varied depending on the surgeon. For one surgeon (Surgeon F), it varied depending on the age of the horse, with younger horses being given a longer period than older horses. Each individual surgeon tended to have a post operative protocol that was uniformly followed for all of that surgeon's cases and was based upon the response and progression of the first few horses operated by that particular surgeon using this technique. At the first recheck examination, the horse was re-evaluated by lameness examination with or without follow-up radiography. If soundness was noted at the trot and the radiographs showed signs of improvement subjectively (decrease in size of the SCL or increase in opacity of the SCL), return to work was recommended. If the horse was not sound at 30 or 60 days, another 30–60 days of rest was recommended.

Radiographic assessment

Radiographs were reviewed to determine lesion type and size. For lesion typing, a modification (Fig 3) of the classification by Howard *et al.* (1995) was used. Size measurements were taken

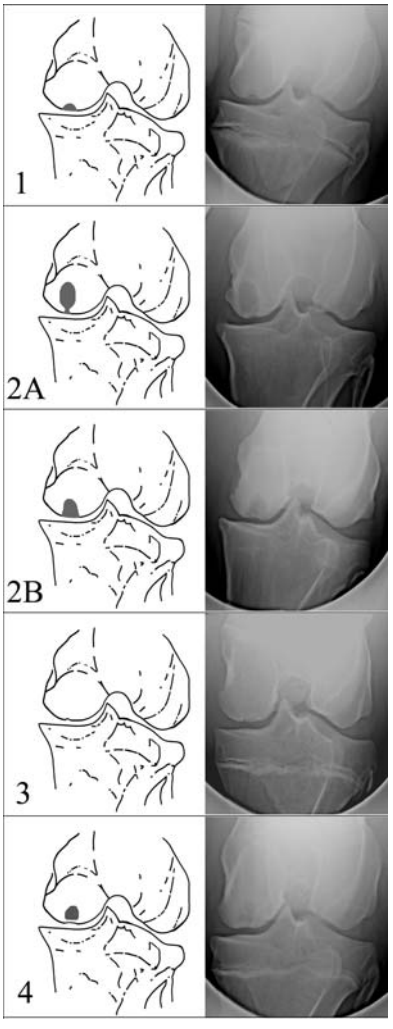

Fig 3: Type 1 *lesions were defined as being <10 mm in depth and were usually dome shaped.* Type 2A *lesions were >10 mm in depth and had a lollipop or mushroom shape with a narrow cloaca and a round cystic lucency.* Type 2B *lesions were >10 mm in depth with a large dome shape extending down to a large articular surface defect.* Type 3 *lesions were defined as condylar flattening or small defects in the subchondral bone, usually noted in the contralateral limb to that of the clinically significant SCL.* Type 4 *lesions were defined as those that had a lucency in the condyle with or without an articular defect, but had no radiographic evidence of a cloaca in the subchondral bone plate.*

using the caudocranial radiographic view of the stifle. Measurements taken of the SCL and the medial femoral condyle were used to calculate a ratio (Fig 4). In this manner, differences in magnification were compensated for between examinations to allow objective comparison. Radiographs and radiographic reports were also reviewed for signs of osteoarthritis.

Follow-up and outcome parameters

Follow-up information was obtained from veterinary recheck examination and telephone survey of owners on every case. The survey obtained information on intended use of the horse, previous medical therapy, period of convalescence, present use of the horse, and degree of lameness (or soundness). Follow-up examinations by veterinarians included physical and lameness examinations and, in most cases, radiography.

Fig 4: Measurements were taken of the height and width of the SCL, as well as the width of the MFC for use as a ratio. The height and width of the SCL were added and the total was divided by the MFC width.

Two groups of comparisons were made: the first evaluated success by the SCL independent of any other confounding variables within the horse; the second evaluated success by the horse. The only way to define success by SCL was as a sound leg at the end of the follow-up period. While this was useful, in that all other variables were excluded, it does not provide a defined clinical outcome from a biological standpoint. For this reason, when considering outcome by horse, success for the surgical procedure was defined as the horse being able to perform without lameness in its intended performance discipline. Horses that returned without lameness to their intended discipline, but were later retired for injuries to other limbs, were also included in this group. A second classification included horses classified as sound by the surgeon or referring veterinarian on follow-up examination, but did not return to their intended use at the owner's discretion. This group includes horses retired for breeding purposes, younger horses that were still in training, but had not yet performed, and horses that the owners decided to use for other occupations. All other horses were classified as unsuccessful (Table 1).

Statistics

Chi-square analysis was performed to compare outcome to age group (age 0–3 years vs. age >3 years), sex, breed, leg, bilateral vs. unilateral, surgeon, SCL type, presence of osteophytes on preoperative radiographs, improvement in size, corticosteroid used, intended discipline of the horse, time to re-evaluation and return to exercise, injection technique, arthroscopic evidence of articular cartilage damage unassociated with the cystic cloaca, and arthroscopic evidence of soft tissue injury in the stifle, such as meniscal damage, cranial cruciate ligament injury, caudal cruciate

TABLE 1: Definitions of different outcomes

Outcome	Definition	No. of cases
Successful horse	Horse was able to perform without lameness in its intended athletic discipline	35/52 (67%)
Sound horse	Horse (both legs if bilateral lesions) was free of any lameness, but horse was not necessarily performing its originally intended athletic discipline	40/52 (77%)
Successful SCL	Limb was free of any lameness	56/73 (77%)

ligament injury, or injury of the cranial ligament of the medial meniscus. Chi-square analysis was also used to find associations between surgeon and any of the above factors that were found to be significant, and this was used to make comparisons between outcome and surgeon controlling for those same factors. Significance was set at $P<0.05$.

Results

Records from 52 horses with SCLs in the MFC, including a total of 73 SCLs, were evaluated. Complete follow-up data was not available on the remaining 10 cases and they were excluded from the analysis. Twenty-two horses were operated at Colorado State University Veterinary Teaching Hospital, 19 at Equine Medical Center in Cypress, California, and 11 cases in various private clinics. Mean ± s.e. age at time of surgery was 3.1 ± 0.3 years (range 1–11 years, median 2 years). There were 33 SCLs in the left leg, 39 in the right, and in one case it was unknown which leg was affected because radiographs were unavailable and the surgery report had no record of which leg was operated. Mean ± s.e. lameness grade for all SCLs in the study for which grade of lameness was recorded was 1.5 ± 0.2 out of 5 on the AAEP lameness scale (median 2, range 0–4) (Ross 2003). Lameness grade was only included for both limbs in bilaterally affected horses if the more lame leg was blocked sound with intra-articular anaesthesia, therefore allowing the less lame leg to be graded.

TABLE 2: Summary of success by various factors

Factor	Success rate by SCL	P value	Factor	Success rate by SCL	P value
Size of SCL		0.66	**Sex**		0.08
Decrease in size	7/9 (78%)		Female	27/31 (87%)	
No change (or increase) in size	9/13 (69%)		Gelding	12/20 (60%)	
Unknown	40/51 (78%)		Stallion	17/22 (77%)	
Surgeon		0.007	**Intended use**		0.15
A	2/2 (100%)		Racehorse	16/18 (89%)	
B	28/30 (93%)		Cutting horse	6/11 (55%)	
C	8/9 (89%)		Show horse	6/6 (100%)	
D	7/9 (78%)		Halter horse	3 /4 (75%)	
E	2/3 (67%)		Trail riding	3/6 (50%)	
F	4/8 (50%)		Reining	5/6 (83%)	
G	5/12 (42%)		Roping	1/2 (50%)	
			Western pleasure	3/3 (100%)	
Age		0.60	Event	2/2 (100%)	
≤3 years of age	43/55 (78%)		Dressage	2 /2 (100%)	
>3 years of age	13/18 (72%)		Breeding stallion	0/1 (0%)	
			Endurance horse	1/1 (100%)	
Preoperative osteophytes		0.04	Unknown	8/11 (73%)	
Present	10/16 (63%)				
Absent	39/45 (87%)		**Corticosteroid used***		0.09
Unknown	7/12 (58%)		MPA	3/4 (75%)	
			TA	42/52 (81%)	
Breed		0.07	TH	3/5 (60%)	
American Paint Horse	5/10 (50%)		TD	0/2 (0%)	
Arabian	6/6 (100%)		MPA + TA	8/10 (80%)	
Hanoverian	1/1 (100%)				
American Quarter Horse	26/36 (72%)		**Leg**		0.85
Thoroughbred	18/20 (90%)		Right	30/39 (77%)	
			Left	25/33 (76%)	
Lesion type		0.86	Unknown	1/1 (100%)	
Type 1	10 /12 (83%)				
Type 2A	20/24 (83%)		**Number of lesions**		0.02
Type 2B	12/16 (75%)		Unilateral	28/31 (90%)	
Type 3	3/4 (75%)		Bilateral	28/42 (67%)	
Type 4	3/3 (100%)				
Unknown	8/14 (57%)		**Other cartilage damage**		0.38
			Present	5/8 (63%)	
Preoperative lameness grade			Absent	46/60 (77%)	
(0-5 AAEP Scale)		0.21	Unknown	5/5 (100%)	
Grade 0	10/14 (71%)				
Grade 1	4/5 (80%)		**Other soft tissue damage**		0.08
Grade 2	7/9 (78%)		Present	4/8 (50%)	
Grade 3	5/7 (71%)		Absent	47/60 (78%)	
Grade 4	1/4 (25%)		Unknown	5/5 (100%)	
Unknown	29/34 (85%)				
			Injection technique		0.01
Re-evaluation (days)		0.02	Multiple sites	39/44 (89%)	
30	8/9 (89%)		Multiple directions	9/15 (60%)	
60	33/38 (87%)		Single site	8/14 (57%)	
90	15/26 (58%)				

*MPA = methylprednisolone acetate, TA = triamcinolone acetonide, TH = triamcinolone hexacetonide, TD = triamcinolone diacetate.

When considering the lameness grade by the horse, only the more severely affected limb was considered for bilateral cases, and mean ± s.e. lameness grade for all horses in the study was 2.4 ± 0.2 out of 5 (median 2, range 1–4). Previous treatment with conservative therapy was performed on 7 horses, while 45 horses were not managed conservatively prior to surgical intervention. Mean ± s.e. time to follow-up was 485 ± 39 days (range 180–1460 days, median 386 days).

Results are summarised in Tables 1 and 2. There was no significant association found between success and which leg was affected, the grade of lameness preoperatively, or the intended discipline of the horse. When considering the results for an individual horse, the more severely affected leg (if a bilateral case) was used for statistical analysis, and in bilateral cases both legs had to be sound and the horse in its originally intended athletic discipline to be considered successful. Overall, 35 of 52 (67%) horses were classified as successful. An additional 5 horses, giving a total of 40 of 52 (77%) were considered sound on veterinary recheck examination, but for various reasons were not performing their intended athletic discipline. When no other variable is considered other than the presence of an SCL, 56 of 73 SCLs (77%) treated by this procedure resulted in a sound leg.

There was a trend toward a significant difference in success based on the sex of the horse (P = 0.08), with 27 of 31 (87%) SCLs from females, 12 of 20 (60%) SCLs from geldings, and 17 of 22 (77%) SCLs from stallions being classified as successful. Of the SCLs, 31 were unilateral and 42 were bilateral cases. Significantly more unilateral SCLs were considered successful than bilateral SCLs (P = 0.02). Of the SCLs from unilateral cases, 28 of 31 (90%) were considered successful, and of the bilateral SCLs, 28 of 42 (67%) were considered successful. This equates to 25 of 31 horses with unilateral SCLs (81%) classified as successful vs. 10 of 21 horses with bilateral SCLs (48%), (P = 0.01).

Since this technique has not been reported previously, various surgeons used various corticosteroids and dosages for injection. There was a trend toward a significant difference (P = 0.09) associated with the products used.

In a review of the surgery reports, it was found that corticosteroids were noted to leak back into the joint out of the cloaca of the SCL as viewed arthroscopically from 6 SCLs but only one was classified as unsuccessful. Seven SCLs had an osteochondral flap overlying or immediately adjacent to the cloaca that was debrided.

The change in SCL size was recorded on 22 SCLs that had pre- and post operative radiographs available. Seven of 9 (78%) SCLs revealed a decrease in size and were classified as successful, while 9 of 13 (69%) SCLs did not reveal a change in size but were still classified as successful. Only one of 22 SCLs had evidence of enlargement post operatively, and this was unsuccessful.

There was no significant association found between success and age when separated into age groups of 3 years or less and greater than 3 years of age. Forty-three of 55 (78%) SCLs in horses age 0–3 years and 13 of 18 (72%) SCLs in horses age >3 years were classified as successful. This equates to 27 of 39 (69%) horses age 0–3 years and 8 of 13 (62%) age >3 years classified as successful.

Follow-up was available for 59 SCLs where preoperative radiographs were available for determination of lesion type. There was no significant association between lesion type and success. Radiographic findings of osteophytes were found on preoperative radiographs or listed in the radiographic report of 16 of 61 SCLs (26%). There was a significant association between absence of these osteophytes and success (P = 0.04). Ten of 16 limbs (63%) with these radiographic signs were classified as successful, as compared to 39 of 45 (87%) without any radiographic osteophytes being classified as successful.

There was a trend toward a significant association (P = 0.07) between breed and success. Six of 6 SCLs (100%) in Arabians, one (100%) Hanoverian, 18 of 20 (90%) in Thoroughbreds, 26 of 36 (72%) in American Quarter Horses and 5 of 10 (50%) in American Paint Horses, were classified as successful. Returning to sound intended use were the single (100%) Hanoverian, 13 of 16 (81%) Thoroughbreds, 4 of 5 (80%) Arabians (one horse with bilateral SCL was sound in both legs but had not yet entered training), 15 of 23 (65%) Quarter Horses, and 2 of 7 (29%) American Paint.

Cartilage damage, not associated with the cloaca of the SCL, was found in 8 of 68 cases. Of these 8 SCLs, 5 were classified as successful (63%), compared to 46 of 60 (77%) without signs of cartilage damage being classified as successful, which is not statistically significant. However, there was a trend towards a significant difference (P = 0.08) in success based upon the presence of other soft tissue damage within the joint, such as fraying of the medial cranial meniscotibial ligament (most common finding). Only 4 of 8 (50%) SCLs with other soft tissue damage in the joint were classified as successful, compared to 47 of 60 (78%) SCLs without other soft tissue damage being successful.

There was a significant association between time to first re-evaluation (and, therefore, return to exercise if the horse was sound) and success (P = 0.02). Eight of 9 (89%) SCLs re-evaluated at 30 days and 33 of 38 (87%) at 60 days were successful, with only 15 of 26 (58%) SCLs being successful when they were not first re-evaluated until 90 days post operatively.

A significant association was found between the specific injection technique used to deposit the corticosteroids in the lining of the SCL and success. Of 44 SCLs, 39 (89%) were successful when the lining was injected by advancing the needle through multiple sites around the cloaca into the depth of the cyst. Only 9 of 15 (60%) SCLs were successful when the corticosteroid was deposited using a bent needle advanced in multiple directions through the cloaca. One surgeon (Surgeon C) had 8 of 9 (89%) SCLs with a successful outcome using this technique; however, the only other surgeon (Surgeon G) to use this technique had one of 6 (17%) SCLs with a successful outcome and employed this technique for the second half of the study period, being the only surgeon to change techniques during the study period. Only 8 of 14 (57%) SCLs were successful when the total amount of corticosteroid was deposited in one location once the needle was presumed to have been placed into the lining.

There was a significant association between a SCL being classified as successful and the surgeon who operated the case (P = 0.007). Measures of associations were run between surgeons and all factors found to be significant predictors of success and significant interactions were found between surgeons and the type of corticosteroid used (P<0.0001), the post operative re-evaluation protocol used (P<0.0001), and the injection technique used (P<0.0001). There was also an interaction between surgeon and cases which had osteophytes on preoperative radiographs (P = 0.01). There was no significant interaction between surgeon and the sex of horse (P = 0.13).

In order to determine if certain surgeons operated more cases with a factor that was found to have a more or less successful

outcome, analyses were run including only Quarter Horses and Thoroughbreds, unilateral SCLs, and SCLs from geldings, and the statistical significance by surgeon remained. When analyses were limited to SCLs injected through multiple injection sites adjacent to the cloaca, SCLs with presence or absence of osteophytes on preoperative radiographs, SCLs from mares or stallions, and SCLs first re-evaluated at 30 or 60 days, there was no statistical difference in outcome by surgeon.

Discussion

This study reports that 56 of 73 SCLs (77%) responded to treatment, which equates to 35 of 52 horses (67%). This technique was developed by one of the authors (C.W.M.), based on previously reported findings that the fibrous tissue of SCLs produce inflammatory mediators, such as nitric oxide, prostaglandin E2 and neutral metalloproteinases, which activate osteoclasts and enhance bone resorption (von Rechenberg *et al.* 2000), as well as knowledge that methylprednisolone acetate was used to treat unicameral bone SCLs in human subjects successfully (Scaglietti *et al.* 1982). Results of a similar technique to that in the present study were presented by Vandekeybus *et al.* (1999) and showed favourable results. In that particular report, the use of a combination of intra- and extra-articular approaches resulted in 11 of 21 horses returning to athletic use (Vandekeybus *et al.* 1999).

In the present study, an effort was made to inject into relatively solid tissue within the SCL (cyst lining) to avoid loss of corticosteroid into the joint cavity. This is usually accomplished by advancing the needle into the SCL from 3 to 4 different angles through and adjacent to the cloaca. When the fibrous tissue is successfully penetrated, the cartilage overlying the SCL can be observed to bulge under pressure, and little or no corticosteroid can be seen to exit the cloaca and enter the joint. In 6 horses, in which a significant portion of the corticosteroid was seen to leak from the cloaca into the joint, only one was classified as unsuccessful. It must be assumed that this product was seen leaking back into the synovial cavity only after the fibrous tissue was filled under pressure.

We began using the technique as described because injection utilising arthroscopic surgery, as opposed to transcutaneous injection via ultrasound guidance, allowed visualisation of the cartilage surface. Although it has been argued that it is economically advantageous to perform the injection under short-acting injectable anaesthesia without entering the joint arthroscopically, avoiding the risk of missing a cartilage lesion or other soft tissue damage in need of debridement might outweigh the increased cost of the arthroscopic procedure. In our series of cases, 7 of 73 SCLs had an associated osteochondral flap overlying or immediately adjacent to the cloaca that required debridement. These flaps would have been left in the joint with ultrasound-guided injection, potentially leading to an unsuccessful result.

The technique described here is now used as a first option by the authors, as it yields a similar chance of success as debridement (67% in Howard *et al.* 1995 and 35–64% in Smith *et al.* 2005), with multiple advantages. In the present study only one of 22 SCLs for which post operative radiographs were available for review enlarged after treatment. In the study published by Howard *et al.* (1995), 9 of 39 horses had documented evidence of cystic enlargement. In that study there was a significant association between subchondral drilling and enlargement of the SCL (Howard *et al.* 1995), but the authors have seen enlargement subsequent to debridement in the absence of forage.

Another advantage to this technique is a greatly decreased period of convalescence. Howard *et al.* (1995) reported resting the horses for a minimum of 6 months post debridement before returning to work. In our experience, this time period can often be in excess of 8 months, which is supported by Smith *et al.* (2005) who reported a median of 8 months for young horses to return to work, with a median of 24 months for return to the previous level of work (longer for horses age ≥3 years). All of the horses in the present study that were classified as successful were trotting soundly at the first recheck (30, 60 or 90 days) and returned to training at that time, with the exception of one, which was rested for 6 months before being able to return to competition. Another horse required 9 months convalescence to return to soundness and was beginning training at the time of writing.

With this technique, there was less disruption of the articular surface compared to debridement of the SCL where removal of variable portions of the weightbearing cartilage is required. Although no absolute measurements of articular surface involvement were evaluated in this study, this variable was indirectly evaluated by lesion type, which showed no significant difference in outcome. Sandler *et al.* (2002) reported on 214 SCLs of the MFC in 150 Thoroughbred racehorses and concluded that the ability to start a race was influenced by the amount of cartilage surface disrupted at surgery. Furthermore, a possible sequel to debridement was identified in a recent report by Hendrix *et al.* (2005), which found an association between debridement of SCLs and subsequent formation of a medial meniscal lesion, or *vice versa*, in 11 cases over a 12 year period. Five of those cases developed a medial meniscal lesion subsequent to debridement of a SCL in the MFC (Hendrix *et al.* 2005).

Preoperative radiographic osteophytes were found to be an indicator of poor prognosis with this technique. There was a much higher prevalence of osteophytes seen on radiographs (16 of 61, 26%) than gross cartilage disease found arthroscopically (8 of 68, 12%). The majority of the osteophytes were small and located on the medial tibial eminence or intercondylar tibial eminence. This would correlate with clinical observations that significant cartilage damage and signs of OA are not always seen arthroscopically until larger osteophytes are seen on the distal femur. Furthermore, smaller osteophytes on the medial tibia and intercondylar tibial eminence do not always correlate with grossly visible cartilage degeneration. Nevertheless, success was significantly lower for SCLs with radiographic findings of osteophytes (63%) (11 of 43 [27%] horses), compared to SCLs without radiographic osteophytes (87%) (27 of 32 [84%] horses) being classified as successful.

There was a trend toward a significant difference between different breeds and success ($P = 0.07$). Further investigation is needed to determine if there are potential differences in prognosis for various breeds, such as American Paint Horses. When compared to other breeds and occupations of horses within the present study, the technique appears to be particularly successful in young, racing Thoroughbred horses (all 16 Thoroughbred horses in the study were racehorses age ≤3 years, with 8 being 2-year-olds). Thirteen of 16 (81%) were classified as successful, and 15 of 16 (94%) were classified as sound. Triamcinolone acetonide was used in 15 of 16. The final horse was injected with triamcinolone diacetate due to unavailability of triamcinolone acetonide and remains lame.

Radiographic follow-up does not appear to be a sensitive predictor of success, as there was no significant association between a decrease in lesion size measured on radiographs and a successful outcome. This is in agreement with previous reports with debridement (McIlwraith 1990). However, follow-up radiography is still recommended to ensure the SCL is not enlarging and that there are no further radiographic signs of OA present.

The age of the horse does not appear to be an important prognostic factor, suggesting that this technique may be particularly preferable to debridement in horses age >3 years. This finding should be interpreted with caution due to the fact that only 25% of the horses in the present study were >3 years, but these cases are markedly different in success rate compared to those of Smith *et al.* (2005) in which only 35% of horses age >3 years had a successful outcome, compared to 64% of horses age ≤3 years.

The difference in success rate among surgeons was initially surprising, but further analysis revealed that surgical technique and post operative exercise protocol are important. SCLs that were injected through multiple injection sites adjacent to the cloaca and into the periphery of the cyst had a significantly better outcome for a variety of surgeons. Those SCLs that had corticosteroid deposited in the lining through a single injection location or by redirecting a bent needle through the cloaca in different directions were less successful, although the latter technique was more dependent on the surgeon. All surgeons attempted to deposit corticosteroid within the fibrous lining of the cyst, but it seems logical that using multiple injection sites results in a more widespread distribution of the corticosteroid within the lining.

It also appears that the time to first re-evaluation and, therefore, return to exercise (if the horse is sound and subjectively improving radiographically) has an effect on the outcome of the case. Horses re-evaluated at 30 or 60 days did significantly better than those horses that were not seen until 90 days post operatively.

In conclusion, arthroscopic injection of the fibrous tissue of subchondral cystic lesions of the medial femoral condyle is an effective alternative to debridement. In this study, age of horse, grade of lameness, lesion type, change in SCL size, leg affected and intended use were not associated with outcome. The success rate was negatively affected when there were osteophytes on preoperative radiographs, when a single injection site into the fibrous lining was used, and when horses were not evaluated until 90 days post operatively. American Paint Horses and geldings, SCLs injected with triamcinolone hexacetonide or triamcinolone diacetate, and SCLs with other soft tissue damage present had a lower percentage success, although these were only trends. Compared to debridement, horses have a faster return to use with less chance of cystic enlargement, probably associated with less disruption of the articular surface of the medial femoral condyle. If the procedure is unsuccessful, the option to debride the lesion remains, with or without the addition of other reconstructive techniques.

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References

Baxter, G.M. (1996) Subchondral cystic lesions in horses. In: *Joint Disease in the Horse*, Eds: C.W. McIlwraith and G.W. Trotter, W.B. Saunders, Philadelphia. pp 384-397.

Bodo, G., Hangody, L., Modis, L. and Hurtig, M. (2004) Autologous osteochondral grafting (mosaic arthroplasty) for treatment of subchondral cystic lesions in the equine stifle and fetlock joints. *Vet. Surg.* **33**, 588-596.

Fortier, L.A. and Nixon, A.J. (2005) New surgical treatments for osteochondritis dissecans and subchondral bone cysts. *Vet. Clin. N. Am.: Equine Pract.* **21**, 673-690, vii.

Hendrix, S.M., Baxter, G.M., Trumble, T.N. and McIlwraith, C.W. (2005) Association between medial meniscal and medial femoral condyle subchondral lesions in horses. *Vet. Surg.* **34**, E12.

Howard, R.D., McIlwraith, C.W. and Trotter, G.W. (1995) Arthroscopic surgery for subchondral cystic lesions of the medial femoral condyle in horses: 41 cases (1988-1991). *J. Am. vet. med. Ass.* **206**, 842-850.

Jackson, W.A., Stick, J.A., Arnoczky, S.P. and Nickels, F.A. (2000) The effect of compacted cancellous bone grafting on the healing of subchondral bone defects of the medial femoral condyle in horses. *Vet. Surg.* **29**, 8-16.

Kold, S.E. and Hickman, J. (1984) Results of treatment of subchondral bone cysts in the medial condyle of the equine femur with an autogenous cancellous bone graft. *Equine vet. J.* **16**, 414-418.

Kold, S.E., Hickman, J. and Melsen, F. (1986) An experimental study of the healing process of equine chondral and osteochondral defects. *Equine vet. J.* **18**, 18-24.

McIlwraith, C.W. (1990) Subchondral cystic lesions in the horse - The indications, methods, and results of surgery. *Equine vet. Educ.* **2**, 75-80.

McIlwraith, C.W. (2002) Diseases of joints, tendons, ligaments, and related structures. In: *Adams' Lameness in Horses*, 5th edn., Ed: T.S. Stashak, Lippincott, Williams & Wilkins, Philadelphia. pp 459-644.

Pool, R.R. (1993) Difficulties in definition of equine osteochondrosis; differentiation of developmental and acquired lesions. *Equine vet. J., Suppl.* **16**, 5-12.

Ray, C.S., Baxter, G.M., McIlwraith, C.W. Trotter, R.W., Powers, B.E., Park, R.D. and Steyn, P.F. (1996) Development of subchondral cystic lesions following articular cartilage and subchondral bone damage in young horses. *Equine vet. J.* **28**, 225-232.

Rejno, S. and Stromberg, B. (1978) Osteochondrosis in the horse. II. Pathology. *Acta Radiol., Suppl.* **358**, 153-178.

Ross, M.W. (2003) Movement. In: *Diagnosis and Management of Lameness in the Horse*, Eds: M.W. Ross and S.J. Dyson, W.B. Saunders, St Louis. pp 60-73.

Sandler, E.A., Bramlage, L.R., Embertson, R.M., Ruggles, A.J. and Frisbie, D.D. (2002) Correlation of radiographic appearance, lesion size, and racing performance, after arthroscopic surgical treatment of subchondral cystic lesions of the medial femoral condyle in thoroughbreds: 150 cases. *Vet. Surg.* **31**, 495.

Scaglietti, O., Marchetti, P.G. and Bartolozzi, P. (1982) Final results obtained in the treatment of bone cysts with methylprednisolone acetate (depo-medrol) and a discussion of results achieved in other bone lesions. *Clin. orthop. Rel. Res.* **165**, 33-42.

Smith, M.A., Walmsley, J.P., Phillips, T.J., Pinchbeck, G.L., Booth, T.M., Greet, T.R., Richardson, D.W., Ross, M.W., Schramme, M.C., Singer, E.R., Smith, R.K. and Clegg, P.D. (2005) Effect of age at presentation on outcome following arthroscopic debridement of subchondral cystic lesions of the medial femoral condyle: 85 horses (1993-2003). *Equine vet. J.* **37**, 175-180.

Vandekeybus, L., Desbrosse, F. and Perrin, R. (1999) Intralesional long acting corticosteroids as a treatment for subchondral cystic lesions in horses. A retrospective study of 22 cases. In: *Proceedings of the 8th Annual Scientific Meeting of the European College of Veterinary Surgeons*. pp 33-34.

Verschooten, F. and De Moor, A. (1982) Subchondral cystic and related lesions affecting the equine pedal bone and stifle. *Equine vet. J.* **14**, 47-54.

von Rechenberg, B., McIlwraith, C.W. and Auer, J.A. (1998) Cystic bone lesions in horses and humans: a comparative review. *Vet. Comp. orthop. Traumatol.* **11**, 8-18.

von Rechenberg, B., Guenther, H., McIlwraith, C.W., Leutenegger, C., Frisbie, D.D., Akens, M.K. and Auer, J.A. (2000) Fibrous tissue of subchondral cystic lesions in horses produce local mediators and neutral metalloproteinases and cause bone resorption *in vitro*. *Vet. Surg.* **29**, 420-429.

White, N.A., McIlwraith, C.W. and Allen, D. (1988) Curettage of subchondral bone cysts in medial femoral condyles of the horse. *Equine vet. J., Suppl.* **6**, 120-124.

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